

Sexual Selection

Why sexual reproduction?

- why not many sexes?
- why not asexual reproduction?
- hermaphrodite?
- homosexual?
- trans-sexual?

Benefits and costs of sexual reproduction?



Asexual reproduction

Parthenogenesis: growth and development of embryos occur without fertilization.

-invertebrates, frogs, sharks, lizards, birds



Red Queen hypothesis

“Well, in our country,” said Alice, “you’d generally get to somewhere else – if you ran very fast for a long time as we have been doing.”

“A slow sort of country!” said the Queen.

“Now, here, you see, it takes all the running you can do to keep in the same place. If you want to get to somewhere else, you must run at least twice as fast as that!”

Alice in Wonderland



Red Queen hypothesis

Evolutionary arm race between hosts and parasites

Sexual reproduction

Increase genetic variation



Increase chance to defend parasites



Evolve better parasite-defense system



Parasites evolve better offense system



Sexual reproduction evolve better defense

Nematode and its parasite

Grew nematodes without parasites

→ 20% sexual reproduction

Grew nematodes with Co-evolved parasites →

80-90 % sexual reproduction

Grew nematodes with non-evolved parasites

→ 20 % sexual reproduction

Sex helped populations adapt to their co-evolving parasites

Nematode and its parasites

Grew mutant nematodes w/ obligate asexual
→ Went extinct (exposed to parasites)

Grew mutant nematodes w/ obligate sexual
→ Population remains stable (exposed to parasites)

Sex helped populations deal with their
coevolving parasites

Sexual Selection

Behavioral (morphological) traits that can be explained by intra-specific competition for reproduction

Darwin (1871): “ a struggle between the individuals of one sex, generally the males, for the possession of the other sex”.

Sexual Selection: 2 forms

1. Inter-sexual selection
(or mate choice)
2. Intra-sexual selection
(male-male competition)

Male-male competition

1. Red deer compete for females



Male-male competition

2. Elephant seals defend territory and dominance



Sexual selection by mate choice

2. Song repertoire



Great reed warbler

Female warblers choose a territorial male who has a larger repertoire size.

Sexual selection by mate choice

2. Dancing courtship in birds of paradise



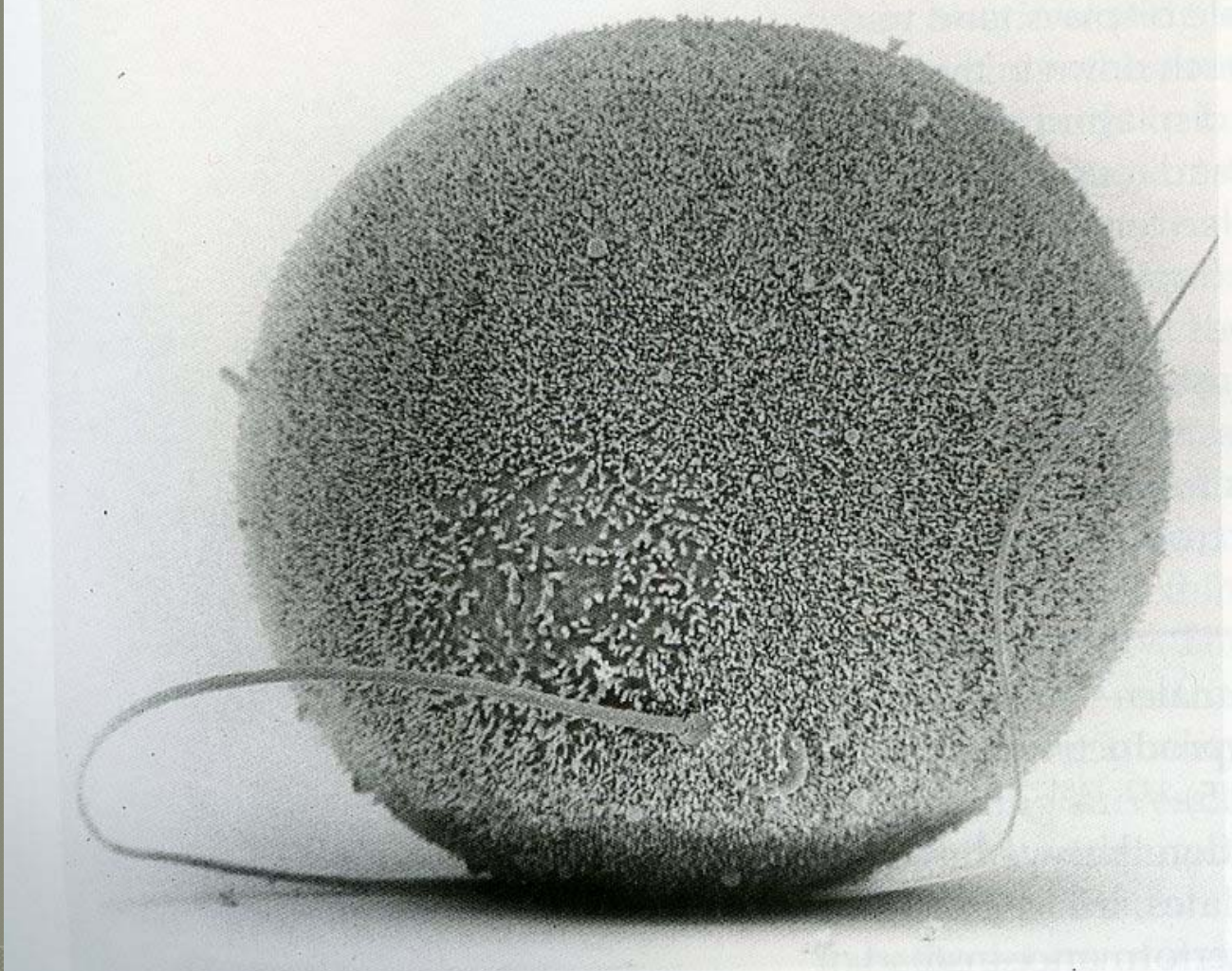
Mate choice

Why females tend to choose males?

Why males tend to have bright plumage, big song repertoire, bigger size (or muscles)?

Why females choose, and males fight?

Males and female gametes differ greatly in size



Why females choose, and males fight?

1. Gamete size:

Female: fewer, larger gametes (eggs),
eggs are costly, valuable.

Male: more, smaller gametes (sperms)
sperms are cheap to produce.

2. Investment on eggs and parental care

Fishes- external/ internal fertilization

Birds- females lay eggs

Mammals- females nurture

Evolutionary models of mate choice what do females choose?

- ①. Direct benefit hypothesis
- ②. Good gene hypothesis
- ③. Runaway hypothesis
- ④. Sensory exploitation hypothesis

What do females choose?

① 1. Direct benefit hypothesis

choose mates provide them
with resources: food, territory
(home), assistance in
parental care....

1. Direct benefit hypothesis

Female scorpionflies choose males that bring large prey items—food

1. Males with no food → rejected!
2. Males with food:
females control the copulation time based on the size of prey!
(why copulation time matters?)
3. What benefit females have by doing so?
4. Evolution of male's strategy?



what do females choose?

- ① Direct benefit hypothesis
- ② Good gene hypothesis
- ③ Runaway hypothesis
- ④ Sensory exploitation hypothesis

2. Good gene hypothesis

- ◉ Females are favored to choose mates that possess “good gene” traits – indirect benefit (there is no direct benefit).
- ◉ Good genes coded for favorable traits : plumage, song repertoire, capability to win a fight, body size.
- ◉ These traits are honest indicators of male quality – costly to produce.

The costlier the trait, the more difficult it is to fake



Why choose these males?

No direct benefit!

Male birds of paradise's plumage /display



“Good gene” traits are costly to produce



Peacock's tail is a handicapped trait, costly to grow and survive.

The tail signals the strength and quality of males
(I can carry these heavy feathers keep them shine, and still survive and healthy)

If a female choose this male

Her offspring will carry the same genes, survive well
With bright feathers

Parasite-resistant is an honest trait



Plumage is a honest
signal of a male's
genetic quality ?

Bright, shiny plumage



Less parasites



Good Immune system



Healthy male



Good gene

I love you!



Is it an honest indicator?

Good gene trait can be revealed by body symmetry



Why symmetry is an honest signal of a male's health?
-- body symmetry signals the developmental health

Choose symmetrical males → symmetrical offspring

When development of symmetry goes wrong



A



Right

Left

A

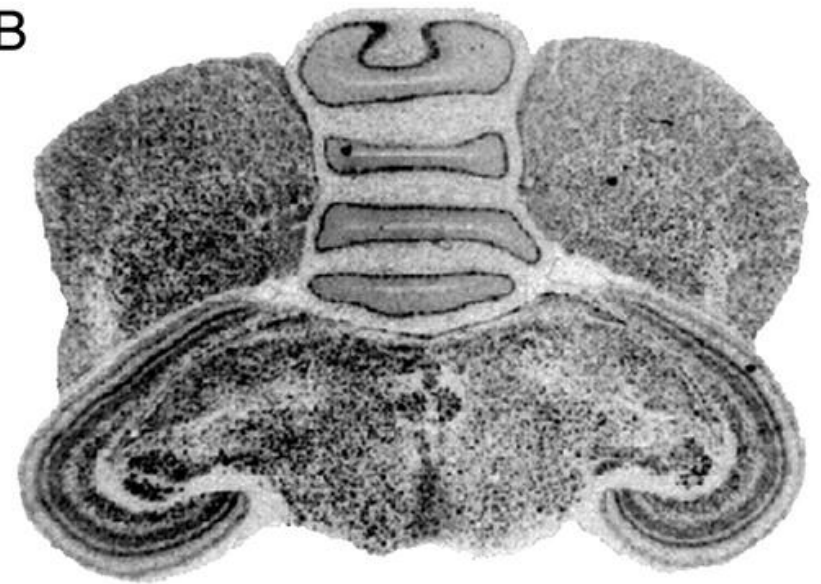


When development of symmetry goes wrong

B



C B



pkci-z

Good gene hypothesis and facial symmetry



FACIAL SYMMETRY

you're doing it wrong...

motifake.com



Symmetry as a honest signal of mate's health?

Good gene hypothesis and MHC gene

MHC-dependent mate preferences in humans

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SUMMARY

One substantial benefit of sexual reproduction could be that it allows animals (including humans) to react rapidly to a continuously changing environmental selection pressure such as coevolving parasites. This counteraction would be most efficient if the females were able to provide their progeny with certain allele combinations for loci which may be crucial in the parasite-host arms race, for example the MHC (major histocompatibility complex). Here we show that the MHC influences both body odours and body odour preferences in humans, and that the women's preferences depend on their hormonal status. Female and male students were typed for their HLA-A, -B and -DR. Each male student wore a T-shirt for two consecutive nights. The next day, each female student was asked to rate the odours of six T-shirts. They scored male body odours as more pleasant when they differed from the men in their MHC than when they were more similar. This difference in odour assessment was reversed when the women rating the odours were taking oral contraceptives. Furthermore, the odours of MHC-dissimilar men remind the test women more often of their own actual or former mates than do the odours of MHC-similar men. This suggests that the MHC or linked genes influence human mate choice today.

What do females choose?

- ① Direct benefit hypothesis
- ② Good gene hypothesis
- ③ Runaway hypothesis
- ④ Sensory exploitation hypothesis

Runaway selection

Female mating preferences for certain male attributes create a positive feedback loop favoring both males with these attributes and female that prefer them.

Male



female



widowbird

Runaway hypothesis



widowbird

Need to have 2 sets of genes

One gene is coded for female preference of longer tail.



The other gene is coded for developing male's longer tail.



Females choose longer and longer tails
Males evolve longer and longer tails.



Runaway process

*** Females gain no direct or indirect benefit by choosing a male.**

Design an experiment to test
Runaway vs. Good gene hypothesis??



widowbird

What do females choose?

- ① Direct benefit hypothesis
- ② Good gene hypothesis
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Sensory exploitation

The evolution of signals that happen to activate established sensory systems of signal receivers in ways that elicit responses favorable to the signal sender

Sensory bias model

Females bluebirds prefer feeding red berries; red berry increase survival/reproduction.

Females evolved sensory bias toward red color.

Male bluebirds who have red colored will be chosen and their red-colored genes pass on

Eventually all the males bluebirds evolve red plumage.



Males offer no direct or indirect benefit to females

Sensory bias model

- Hearing habituation of the same stimulus

male grackles who have monotone

“AAA AAA AAA AAA AAA”

Male
Grackle #1



Females prefer male grackles who have a diverse song

“AAA ABB ACC ABB CAA”

Male
Grackle #2



Sensory bias trait comes from ancestors

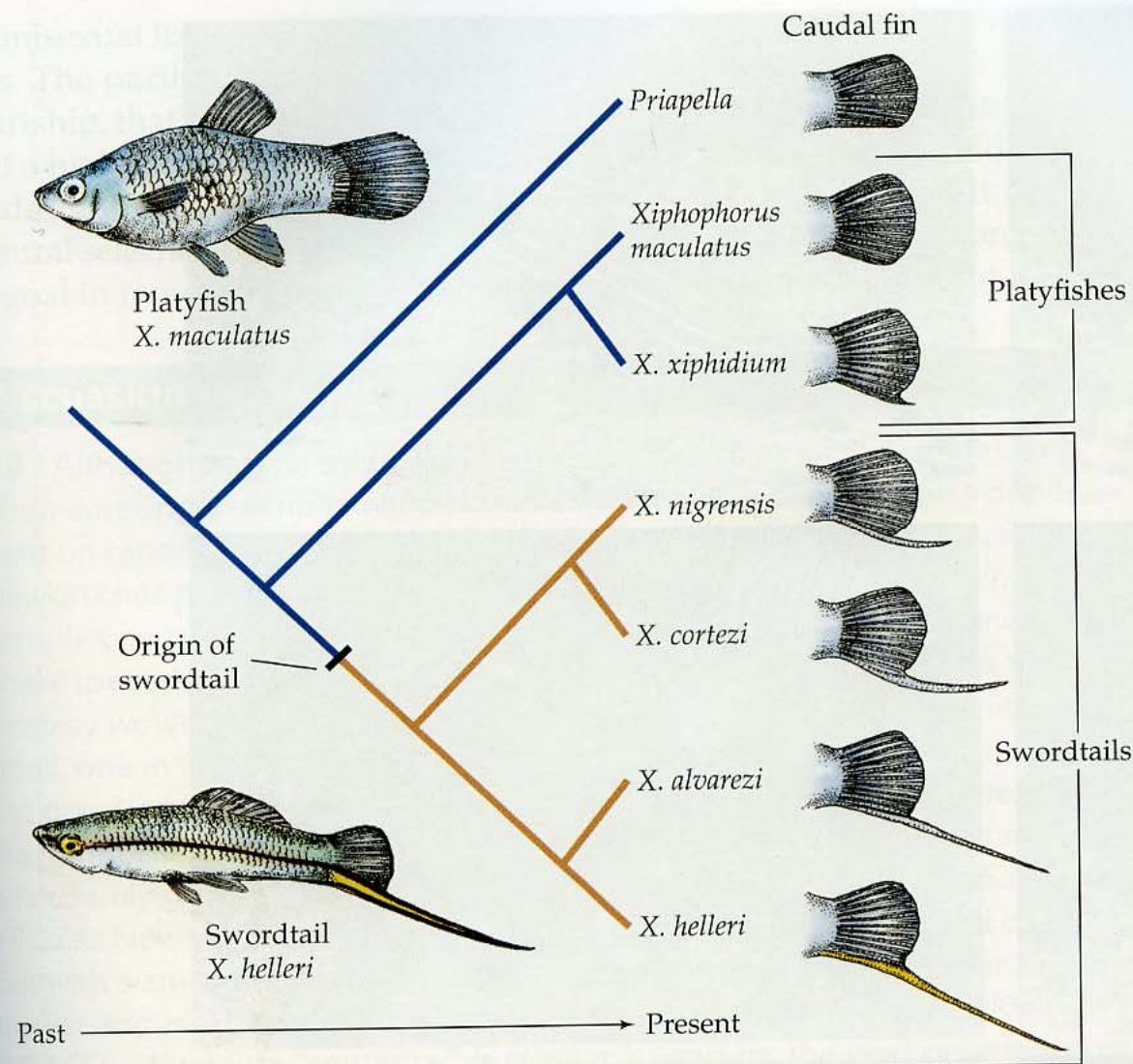


FIGURE 9.22 Sensory exploitation and swordtail phylogeny. The genus *Xiphophorus* includes the swordtails, which have elongated caudal fins, and the platyfishes, a group without tail ornaments. Because the closest relatives of the platyfishes and swordtails belong to a genus (*Priapella*) in which males lack long tails, the ancestor of *Xiphophorus* probably also lacked this trait. The long tail apparently originated in the evolutionary lineage that diverged from the platyfish line. Even so, females of the platyfish *X. maculatus* find males of their species with experimentally lengthened tails more attractive, suggesting that they possess a sensory bias in favor of these kinds of tails. After Basolo.⁷⁹

Sensory bias model –
Female zebra finches choose males
that have red plastic band



Innate color preference

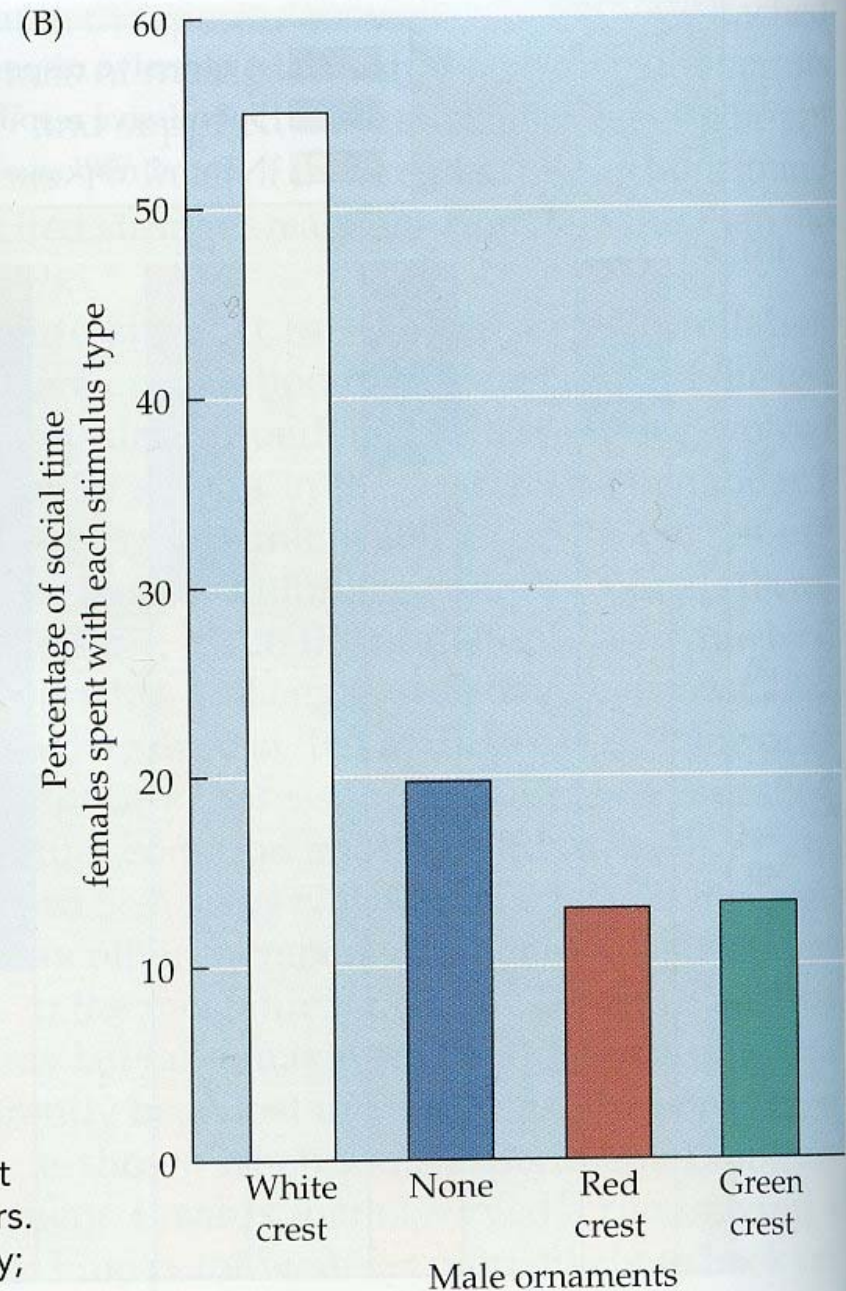


FIGURE 9.21 Mate preferences for a novel ornament. (A) A male long-tailed finch (left) and a male zebra finch (right) have been outfitted with bizarre white plumes. (B) The addition of white plumes made male zebra finches more attractive to females than were control males without plumes or those given headdresses of red or green feathers. A, photograph by Kerry Clayman, courtesy of Nancy Burley; B, after Burley and Symanski.²¹⁴

Runaway model or/and sensory bias model?



Why do females choose?

- ① 1. Direct benefit hypothesis
- ② 2. Good gene hypothesis
- ③ 3. Runaway hypothesis
- ④ 4. Sensory exploitation hypothesis

Runaway model or Sensory bias model ?



what female choice hypothesis?

1. Male satin bowerbirds build bowers
bower is not a nest, it is a display arena

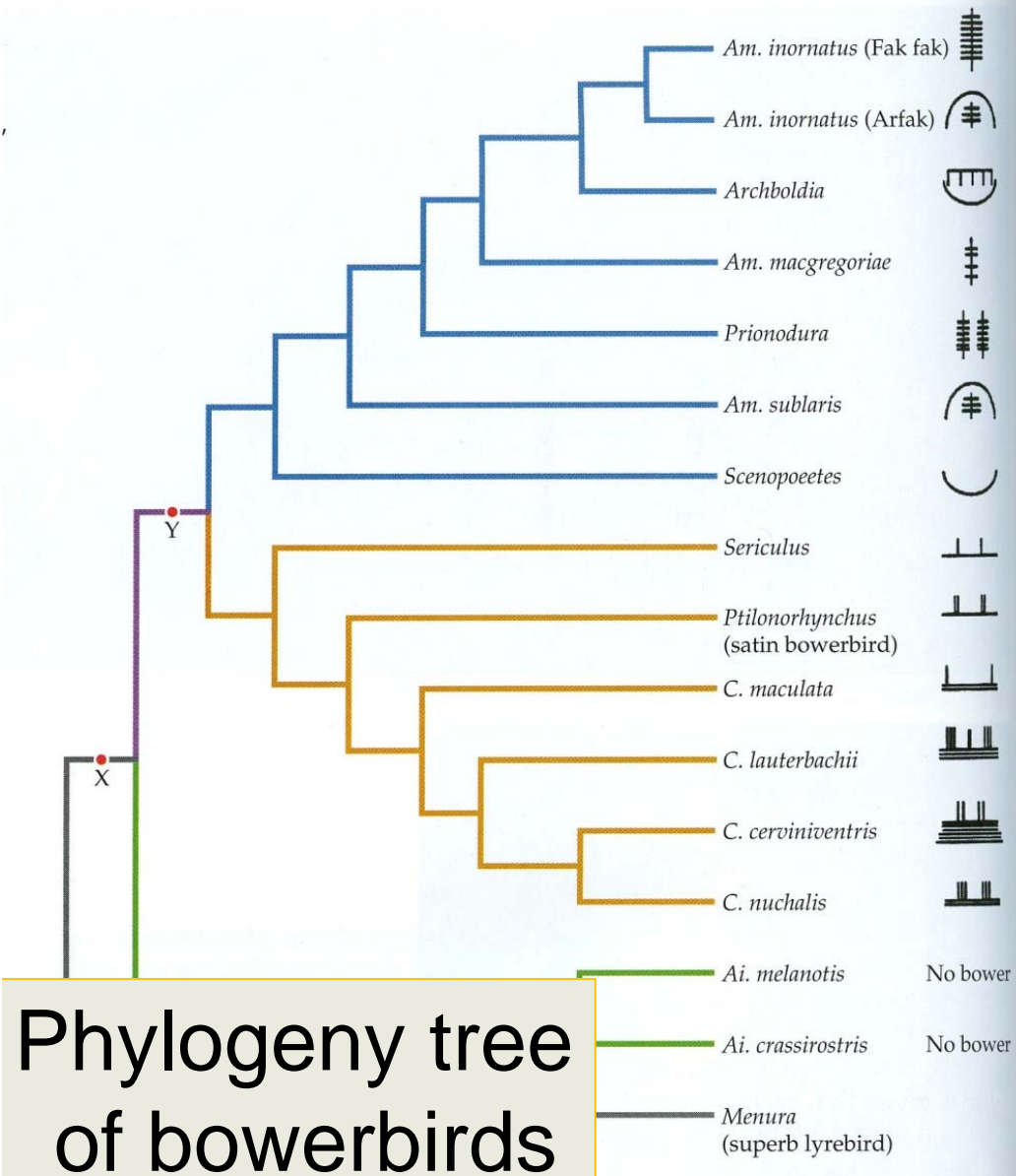


Females visit many bowers, choose one and mate with the male, then leave the male and take care of the eggs and young alone

What is the purpose of building bower?
Building bower is functionally equivalent to
grow bright plumage or produce song.
-- What female choice model?



Different species of bowerbirds build different bowers



2. Male bowerbirds build bowers (video)



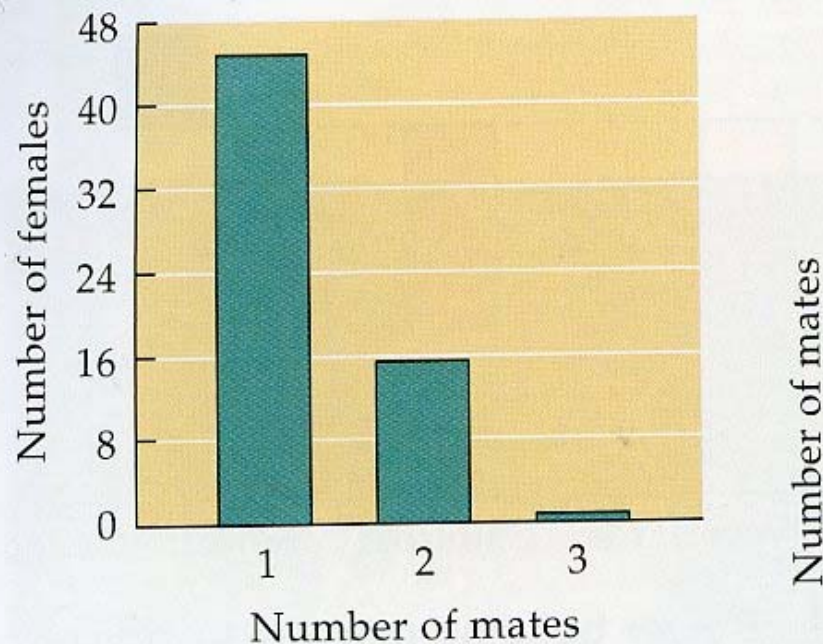
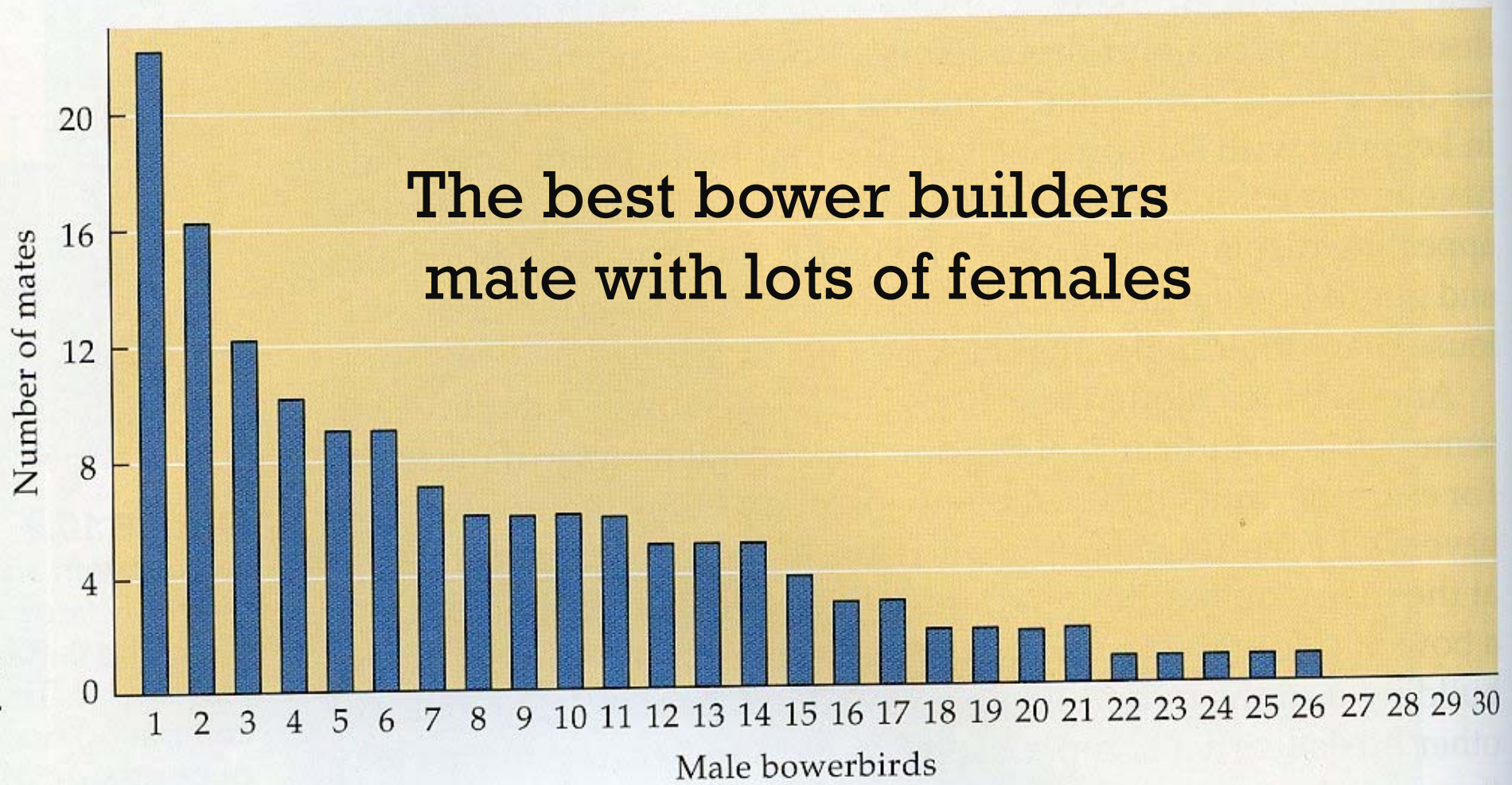


FIGURE 10.5 Variance in reproductive success is greater for males than for females in the satin bowerbird. (A) Very few female bowerbirds have more than two mates per breeding season, and few, if any, use the sperm of more than one male to fertilize their eggs. (B) Some male bowerbirds, however, mate with more than 20 females in a single season, while others do not mate at all. After Uy, Patricelli, and Borgia.¹⁴⁸¹

Most female bowerbirds have only one mate per breeding season

-- so they tend to be very choosy, and look for the best male.

Only a small proportion of bower bird males have high mating success

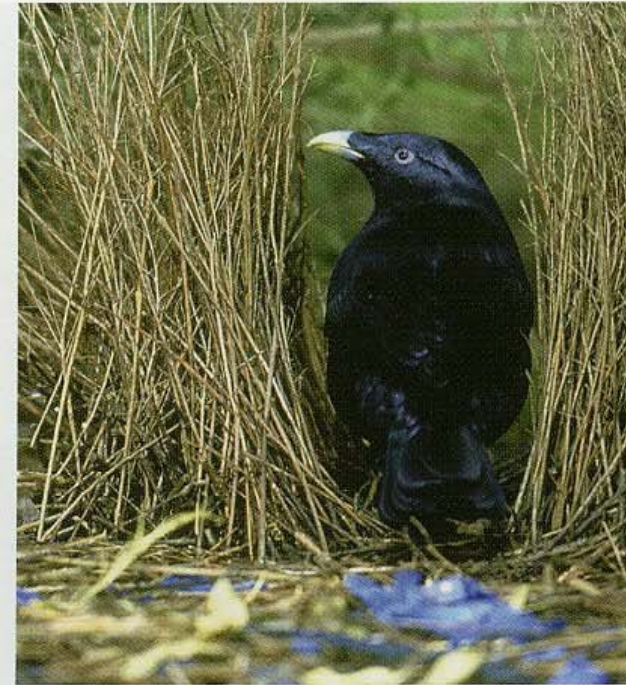
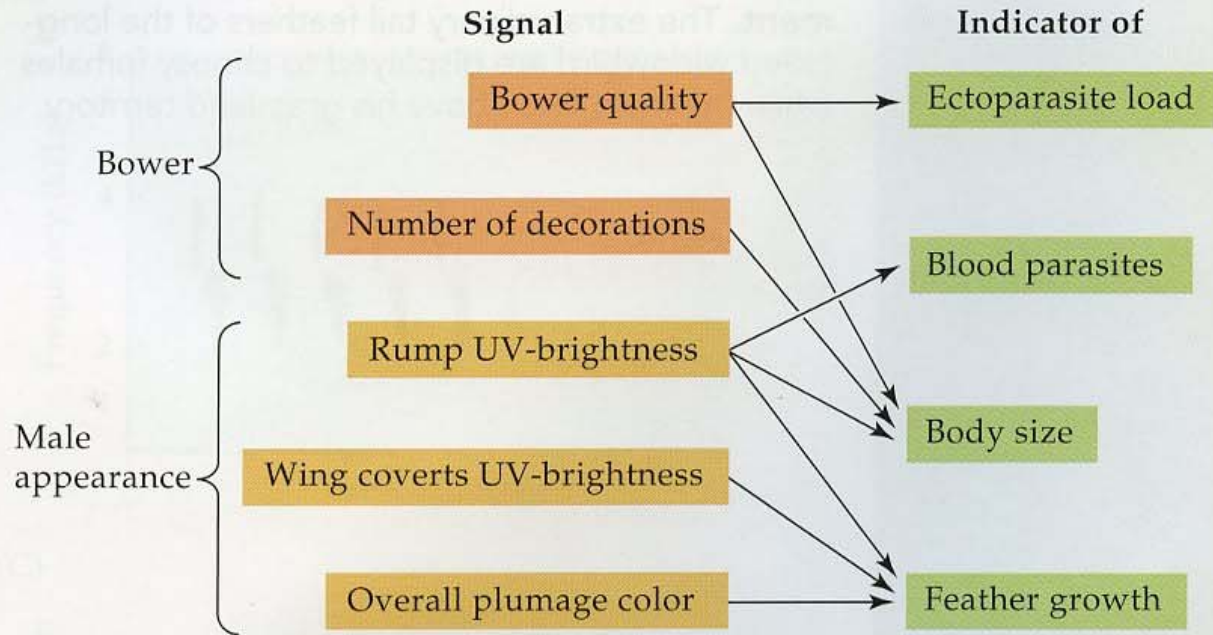


Sexual selection by mate choice

Male satin bowerbirds



What do female birds choose? Not just bower

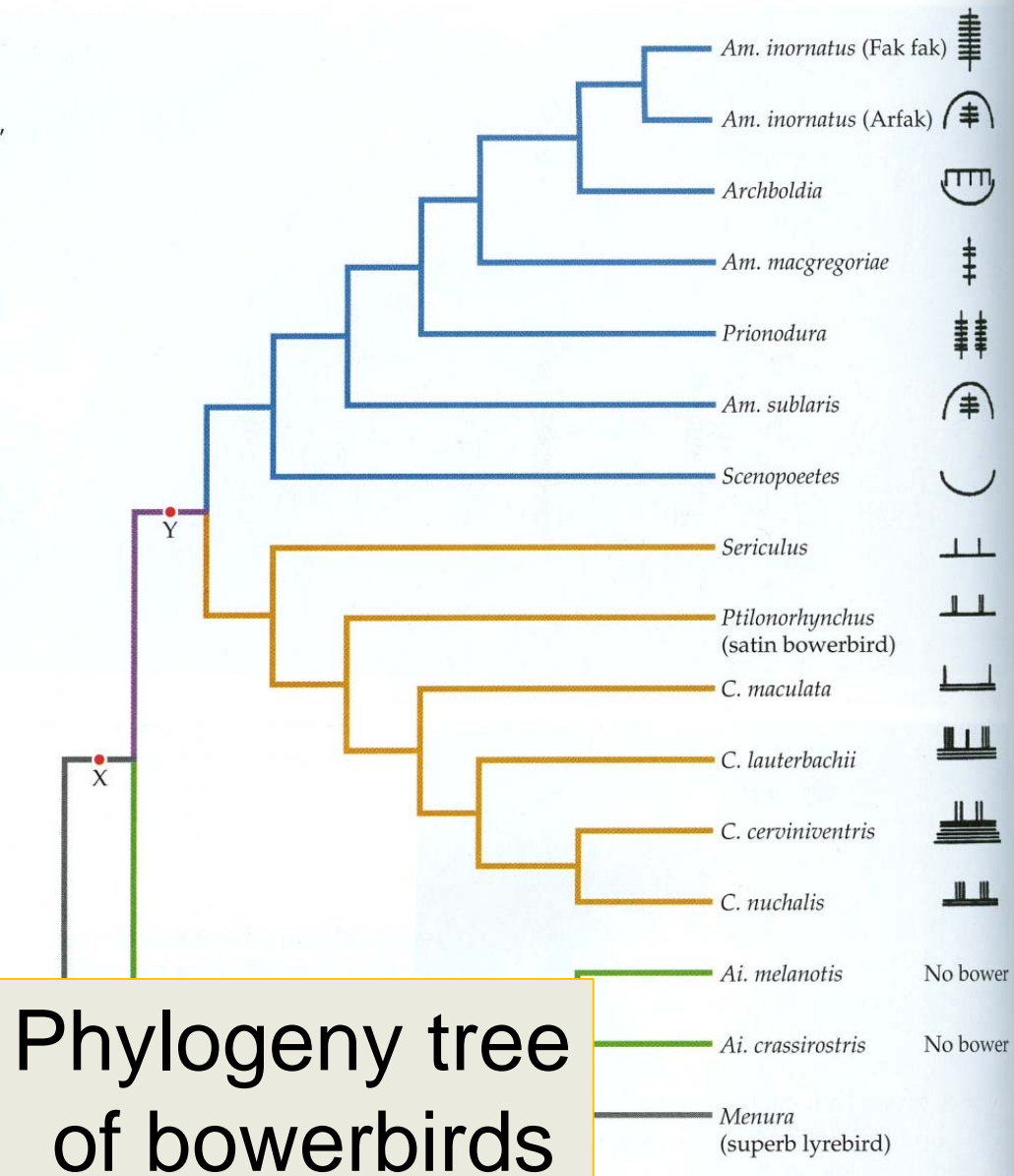


Female sensory bias?

Male satin bowerbirds decorate bower using blue objects, sensory bias for female birds?



Different species of bowerbirds build different bowers



bower-building bowerbirds have bigger brains

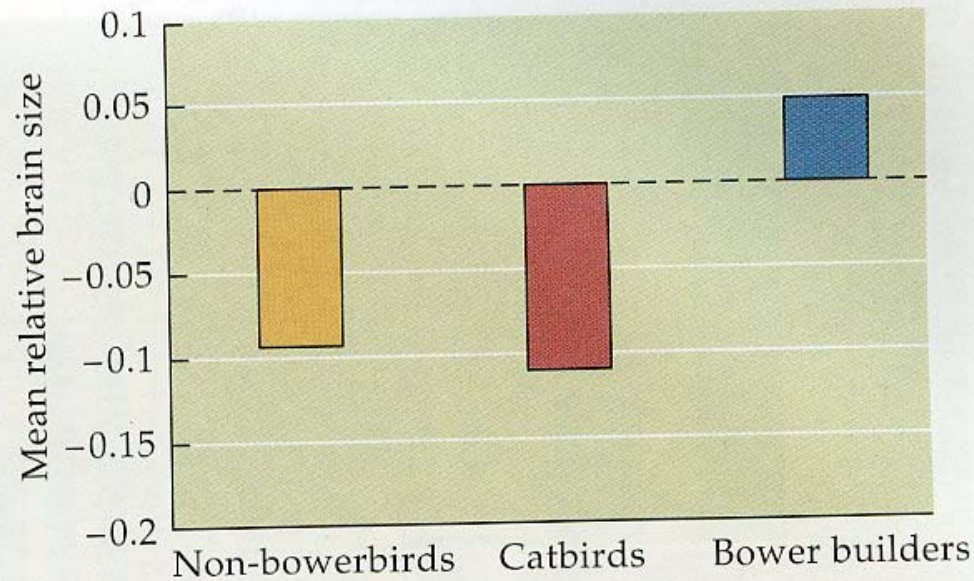


FIGURE 10.4 Bower building may be an indicator of brain size. Bowerbirds that build bowers have relatively large brains compared with other bowerbirds, the catbirds, that merely construct cleared display courts. The mean brain size (as determined by comparing brain cavity volumes against a measure of body size) of the bower-building bowerbirds also far exceeds that of a sample of other, unrelated bird species. After Madden.⁹¹³

Quiz: What female choice model?

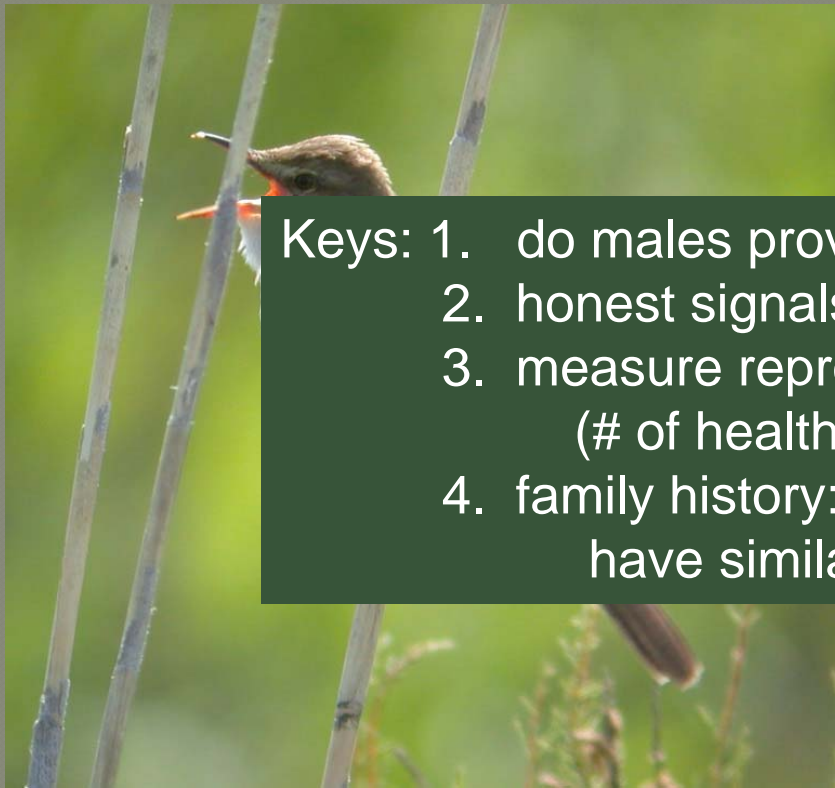
1. Male birds of paradise: plumage/display



- Keys:
1. do males provide benefits?
 2. honest signals (costly to produce)?
 3. measure reproductive success
(# of healthy, viable offspring)
 4. family history: other close relatives
have similar plumage/displays?

Quiz: What female choice models?

2. Song repertoire



Great reed warbler

- Keys:
1. do males provide benefits?
 2. honest signals (costly to produce)?
 3. measure reproductive success
(# of healthy, viable offspring)
 4. family history: other close relatives
have similar plumage/displays?

Female great-reed warblers choose a territorial male who has a large song repertoire and provides parental care.

Sexual Selection: 2 forms

1. Intersexual selection
(or mate choice)

2. Intrasexual selection
(male-male competition)

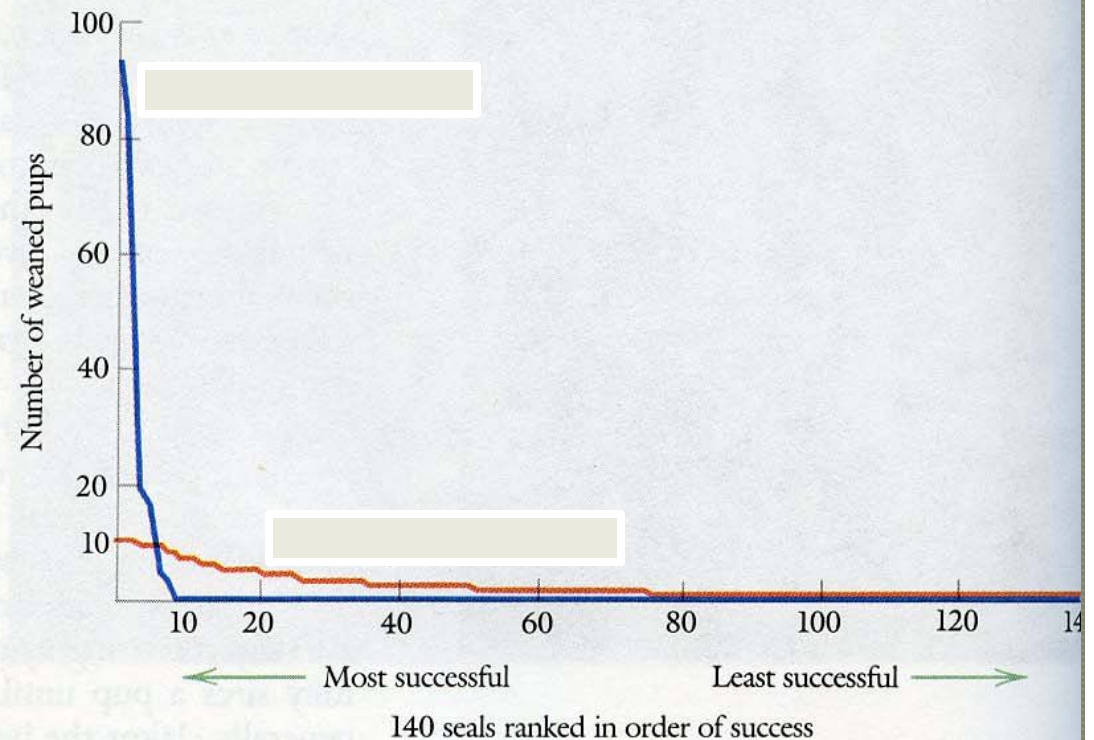
Male-male competition

Elephant seals fight for territory/ dominance





Male reproductive success vs. Female reproductive success



Only a small proportion of males have high reproductive success;
Most females have similar reproductive success

A photograph of a group of male fur seals on a rocky beach. The seals are dark brown with lighter, shaggy fur on their heads and necks. One seal in the center is standing and has its mouth wide open, showing its teeth and tongue, in a display of aggression or competition. Other seals are scattered around it, some looking on. The background consists of dark, porous rocks.

Strategies for male-male competition

Strategies for male-male competition

Elephant seals: males compete for female harem



1. Dominant males
2. Subordinate males
3. Female interference

Cost and benefits to be a dominant male ?

Male-male competition

1. Male red-deers compete for females,
but fighting has a big cost...
so it is the last strategy to use..



First step: Evaluate the antler:
Signal a male's strength/ health



Male-male competition

1. Male red deer's different strategies

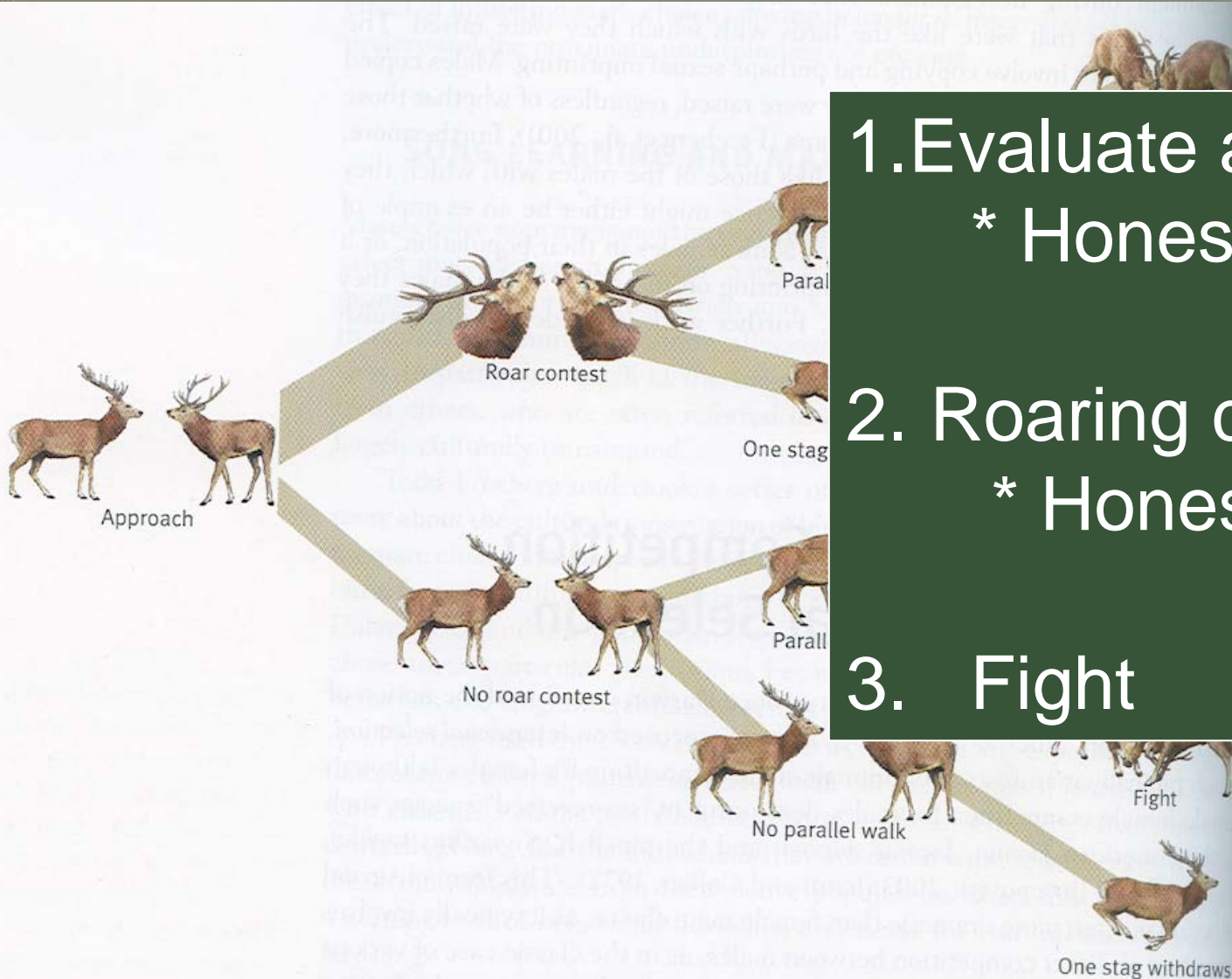
1. Evaluate antler

* Honest indicator!

2. Roaring contest

* Honest signal too!

3. Fight



Strategies for male-male competition

* Bluegill sunfish





Strategies for male-male competition

Three male morphs:

1. Parental male (aggressive, bigger)
2. Sneaker male : “hit and run” strategy
3. Satellite male: looks like females

Strategies for male-male competition

* Bluegill sunfish



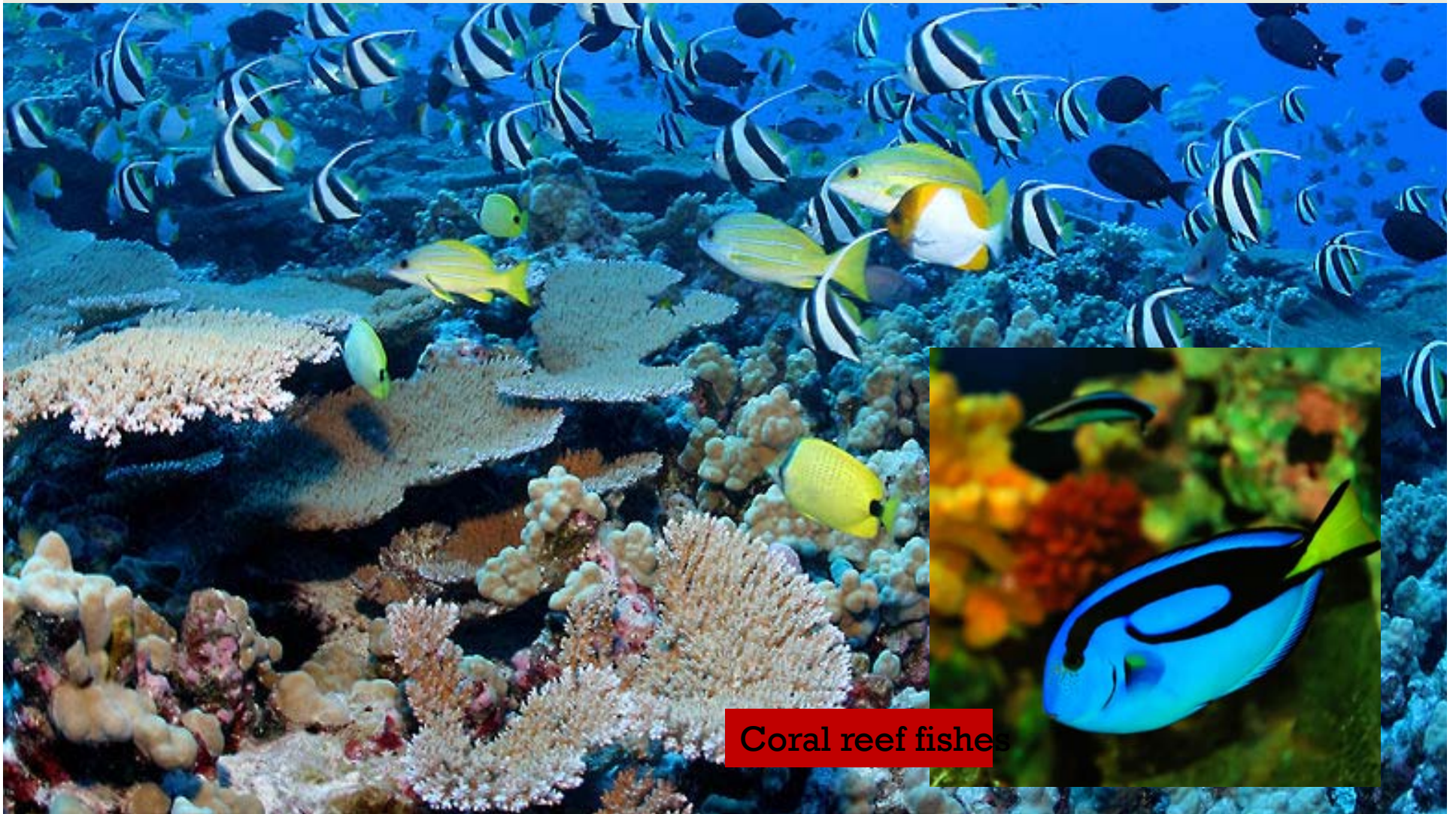
	Sperm quantity	Sperm quality	Sperm life
Parental male	fewer	higher	longer
Sneaker male	more	lower	shorter

Male–male competition

Male's alternative mating strategies

1. Develop friendship with the female (potential mate)
2. Develop friendship with other subordinates
3. Sneaker (when dominant males are not around)
4. Satellite behavior (female-mimicking)
5. Force-copulation

Most fish species have separate sexes,
but many individuals can change sexes



Coral reef fishes

Why should natural selection favor sex change? Under what circumstances might we expect sex change to be adaptive?

Size-advantage model:

an individual that functioned as a female when small and as a male after attaining a large size would have more offspring over its lifetime than one that remained either male or female.

Males: compete females, guard territory and eggs;
→ bigger, stronger males have more reproductive success

A photograph of three clownfish (Amphiprioninae) swimming in a sea anemone. The anemone has many long, yellowish, tube-like tentacles. The clownfish are orange with white stripes and black outlines. They are swimming in a blue, clear water environment. The text "Design an experiment to test the size-advantage model" is overlaid on the top right of the image.

Design an experiment to test the size-advantage model

Remove the big-size male →
smaller female change its sex to male

How do humans choose their mate?

1. Wealth, power (direct benefit)
2. Health (good gene)
3. Odour (good gene: MHC gene)
4. Symmetry (good gene)
5. Look similar to parents (sexual imprinting)
6. Super-stimulus (sensory bias)
7. No reason (runaway or ?)
8. Love at first sight (many possibilities)
9. Cultural, religious, intellectual similarity
10. Combination of above.